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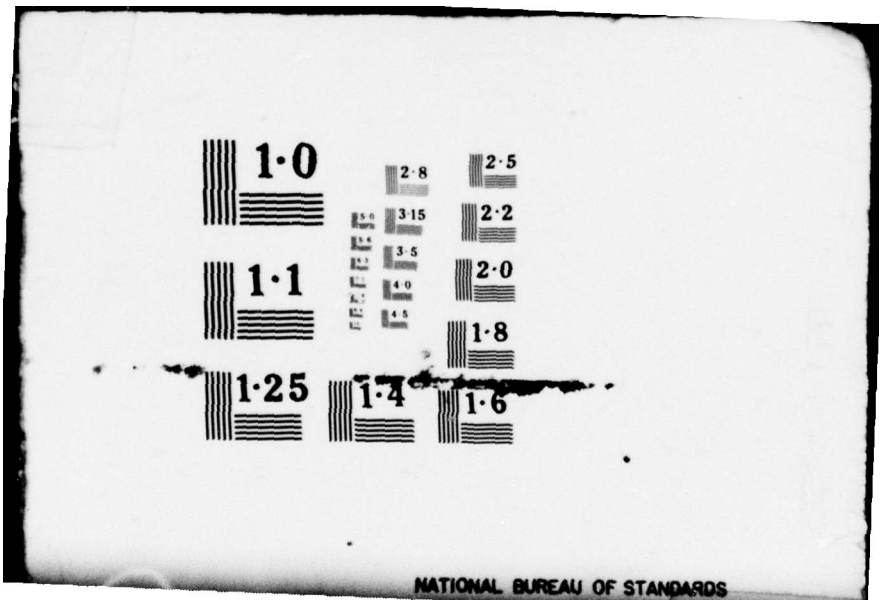
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SEOUL, KOREA
APRIL 23-28,1979

LEVEL II

ADDENDUM TO PROCEEDINGS

The Pacific Conference on Operations Research

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

These Proceedings and the Addendum contain the texts of the keynote speeches, the state-of-the-art lectures, and the papers presented at the Pacific Conference on Operations Research, held April 23-28, 1979, in Seoul, Korea. Analysts and other professonals representing government agencies, academic institutions and industry from 18 countries participated, and a total of 71 presentations were published in the two volumes of the Proceedings and the Addendum.

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ADDENDUM TO PROCEEDINGS

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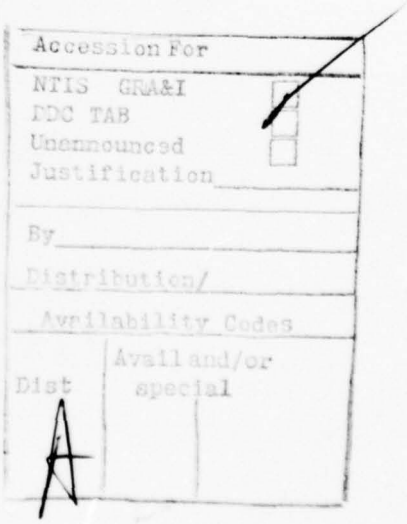

開　　会　　辭

尊敬하는 韓国科学財団 理事長 崔亨燮 博士, 国際運営分析学会聯盟 代表 그라트윌氏, 美太平洋艦隊 副司令官 트로스트 提督, 美 陸軍物資体系分析研究所長 스페라자 博士, 그리고 研究論文을 発表해 주실 国内外 碩学 여러분!

오늘부터 25日까지 開催되는 太平洋地域運営分析会議에 参席하시어 이 会議를 빛내주신 여러분들에게 本人은 大会長으로서 衷心으로 歓迎하며 또 感謝해 마지않는 바입니다.

最近 몇年동안 太平洋地域에서는 1975年 東京에서, 76年 台北에서, 78年 방콕에서 各各 運営分析에 関한 国際会議가 開催되어 成果를 거둔 뒤를 이어 오늘 大韓民国 서울에서 太平洋地域運営分析会議를 갖게 된 것을 지극히 자랑스럽게 생각하는 바입니다.

特히 国際的으로 알려진 百余名의 学者를 모시고 이러한 大大的인 国際会議를 本人이 大会長으로 会議를 주재하게 된 것을 無限한 栄光으로 생각하는 바입니다.

이번 서울에서 열리게 된 本 会議의 内容은 이미 配布된 Program에서 보시다시피 6個分科로 区分되어 進行하게 되겠읍니다만 主催側에서 좀 더 力点을 두었다고 한다면 実際問題 解決을 위한 運営分析技法의 活用 및 応用能力을 向上시키자는데 있읍니다.

体系的으로 運営分析의 方法이 適用된 것은 2次大戦 当時 軍事戦略 및 戦術問題를 数学, 物理学, 心理学等 여러 科学者들로 팀이 되어 解決하였던 것이 始初가 되었다고 하며 그 後 世界各国은 軍事的인 面뿐만 아니라 経営面에서나 行政面에서 이러한 技法을 適用하고 発展시켜 先進 各国은 勿論 後進国까지도 이러한 技法의 適用과 発展이 이루어지고 있는 바입니다.

韓国의 立場을 살펴본다면 李朝 初期에 経国大典이라고 하는 大典을 10余年에 걸쳐 完成하였는데 이 大典은 政府組織, 社会生活의 規範, 産業体制를 設計한 것으로서 이 設計가 System 分析法을 구사하여 이루어졌다고 보고 있으며 李朝 五百余年동안 변함 없이 使用된 大典이 되었던 것입니다. 우리의 祖上들이 이러한 System技法을 이미 使用하였는데도 不拘하고 近代에 와서는 別로 이 分野에 努力을 기울이지 못하였다가 10余年前부터 軍이 이 技法의 適用과 発展에 着眼, 導入하므로서 運営分析의 妙味를 느끼게 되었고 좀 더 組織的으로는 韓国軍事運営分析研究会가 数年前 創立된 後 一般分野까지도 그 必要性을 느끼게 되어 韓国運用科学会가 탄생하여 이제 이 分野의 研究가 本 軌道에 오르게 된 것입니다. 이러한 時期에 여러분을 모시게 된 것은 韓国軍事運営分析研究会나 韓国運用科学会 또는 이 分野에 従事하는 분들의 急進的인 発展을 図謀하는데 있어서 時機 適切하다 하겠읍니다.

本 大会를 위해 世界 18個国에서 오신 碩学 여러분! 그동안 끊임없는 研究로 얻어진 OR 分野의 새로운 研究結果를 大会 期間中 遺憾없이 発表하시고 討論하시어 우리가 展開하는 理論이나 잘 構想된 模型이 世界가 直面하고 있는 現実問題解決의 실마리가 되어 人類福祉의 向上을 가져오는 기틀이 되기를 바라마지 않습니다.

国内에서 参席하신 専門家 여러분!

世界的으로 著名하신 学者들을 오늘 이처럼 한자리에 모시고 直接 그들의 学術発表를 들을 수 있고 個人的으로도 接触할 수 있게 된 것은 우리 모두에게 기쁜 일이 아닐 수 없읍니다. 이러한 機会에 이분들의 知識와 理論을 더 많이 짜아내어서 우리의 当面問題, 即 軍事面뿐만 아니라 一般 問題解決에 도움이 된다면 이것

이 바로 外国学者들을 모시고 서울에서 이 大会를 開催하게 된 目的을 이루게 되는 것입니다.

끝으로 이번 会議期間을 通해 얻어지는 知識으로 政府, 公共機関의 政策決定権者, 企業의 経営者 그리고 軍의 指揮官 여러분이 過去의 経験과 直観力에 더 加味해서 当面 問題解決을 좀 더 科学的으로 処理한다면 이것이 우리가 이 大会를 通해서 期待했던 가장 큰 収獲이라 하겠읍니다.

아무쪼록 이번 大会가 아시아 友邦国家 및 太平洋地域 国家間에 OR分野의 学術的 交流에 크게 이바지하고, 아울러 이를 契機로 앞으로는 이 地域国家들 間에 学術協議会가 構成되고 이것을 通해 運用科学의 学術増進과 相互 技術交流를 提高하며 우리들의 共同 問題를 解決하는 橋梁的 役割이 되었으면 합니다.

오늘 이 大会를 위하여 物心両面으로 많은 支援을 해 주신 関係機関 여러분께 感謝드리고, 오늘에 이르는 準備에 만반을 担当해 주신 準備委員 여러분께 衷心으로 그 労苦를 致賀하며 이 자리에 参席해 주신 国内外 碩学 貴賓 여러분께 対해서도 거듭 感謝드립니다. 特히 멀리 外国에서 오신 여러분께서는 짧은 期間이나마 韓国에 滞在하시는 동안 이 나라의 発展相을 여러모로 보시고 즐거운 時間을 갖기를 바랍니다.

感謝합니다.

1979年 4月 23日

大会長 沈 汶 沢

OPENING ADDRESS

by Dr. Moon Taik Shim
Chairman of the Conference

Mr. Gratwick, Admiral Trost, Dr. Sperrazza, honored speakers, scholars, ladies and gentlemen!

As the Chairman of this Conference, I am pleased to have the honor, on behalf of the Korean Operations Research Society and the Military Operations Research Society of Korea, to welcome you to the Conference, which will be held here in Hotel Shilla for the next three days. Thank you for your outstanding response to our invitation.

In recent years several International and Regional Conferences on Operations Research and Systems Analysis have been held in the Pacific area. In 1975, the IFORS General Meeting was held in Tokyo, in 1976 Taipei hosted the Pacific Conference on Decision Analyses, and last year we had the International Conference on Systems Modeling in Developing Countries in Bangkok. These meetings and the Conference for which we are gathered here in Seoul amply testify to the active interest and progress in operations research activities in the Pacific area.

As you can see in the program, the Conference will be carried out in six sessions. The overall emphasis is on searching for ways to enhance our ability to apply operations research systems analysis techniques to actual problems. The origin of operations research may be found in the effort made by the multidiciplinary team of mathematicians, physicians, psychologists, and members of other profession, to solve military operations problems during World War II. Since then, operations research techniques have been applied by both the developed and developing countries, not only to military matters but also to civil and business management problems. It is interesting to note that here in Korea, an operations research systems analysis type model for a socio-technical system existed already in 1394, at the beginning of Yi dynasty. This model was called "Kyung Kook Dae Chun". It included a governmental organization chart, rules for social life, and plans for industrial complexes. This model was found to be so useful for planning that it was actually used for 500 years

during the Yi Dynasty. Although our ancestors started to utilize operations research techniques long ago, we did not develop these techniques further until the military, some 10 years ago, adopted operations research methods, created analysis agencies, and a few years ago, organized the Military Operations Research Society of Korea.

Operations research is now widely used by both government institutions and business sectors, and the Korea Operations Research Society has been formed. As a consequence, the application of operations research systems analysis methods is gaining increasingly greater acceptatnce in Korea.

Ladies and Gentlemen!

I am confident that scholarly and friendly exchange of ideas during the Conference, on the most recent developments in the field, will result in practical application of operations research systems analysis methods to practical problems. It is a great pleasure for us to be able to listen to presentations by distinguished analysts on recent findings, and to have the opportunity for direct contact with them for next few days. I sincerely urge all participants to learn from these outstanding lecturers and exchange ideas with them, in a unified effort to solve some of the urgent problems confronting our nations.

To those who are here from the government sectors, the policy and decision makers, the managers, and the military people, I extending hope that the Conference will expand your understanding of operations research and systems analysis tools and how these can complement your experience and judgment, and provide you insights for solving complex problems.

I hope that this Conference will be a catalyst for ever-increasing exchange of operations research systems analysis information among our countries, and further, that a Pacific Regional Conference will be formed, with meetings held regularly in the future. May I extend to each of you my best wishes for a rewarding and satisfying Conference, and to the participating organizations my sincere appreciation for their financial and moral support. And from all of us. our heartfelt thanks, for a job well done, to the members of the Organizing Committee who have worked hard to make this Conference a reality.
Thank you very much.

祝　　辭

沈汶沢 大会長, 그라트윌 国際運用分析学会聯盟 副会長, 오늘 이 자리에 参席하신 国内外 学者 및 紳士 淑女 여러분!

오늘 太平洋地域運営分析会議가 이처럼 성황리에 열리게 된것을 衷心으로 祝賀하는 바이며, 本人이 이 会議에서 祝辞를 드리게 된 것을 無限한 栄光으로 생각합니다.

運用科学은 다른 学問에 比하여 그 歷史가 짧은 것이 事実입니다. 그러나 그 짧은 歷史 속에서도 軍事, 企業経営, 公共行政 등 여러 分野에 많은 貢献을 하였으며 또한 이렇게 짧은 期間 동안에 많은 学問的 発展을 거듭하여 오늘에 이르고 있는 것입니다.

今般 太平洋地域 国家들이 相互 協力하여 共同 関心事를 討議하고자 国際会議를 서울에서 開催하게 된 것을 거듭 敬賀해 마지 않는 바입니다.

太平洋地域은 여러面으로 多様한 特性을 가진 地域이라고 하겠읍니다. 莫強한 国富를 자랑하는 나라가 있는가 하면 原始의 生活에서 깨어나지 못하는 나라도 있고, 豊富한 資源으로 부푼 앞날을 約束받은 나라가 있는가 하면 輸出로서 나라의 活路를 開拓하려 努力하고 있는 나라도 있읍니다.

民族이 서로 다르고 文化의 起源이 서로 다르고 그 歷史의 発展이 서로 다름니다만, 이 地域의 共通的인 現象은 大部分의 나라가 高度 経済成長을 追求하고 있다는 点입니다.

이러한 経済成長을 追求하는 政策이나 開発戦略은 各国이 지닌 与件에 따라 当然히 달라져야 하며 그 実践方法과 이룩되는 開発過程도 各己 独特한 様相을 提示하게 되는 것입니다. 이러한 서로 다른 経験을 交換 検討하여 問題의 解決을 為한 새로운 次元을 摸索한다는 것은 大端히 뜻깊은 일이라 하겠읍니다. 이러한 交流를 通해 다른 나라가 犯했던 過誤를 避할 수 있게 되는 것이며 이러한 交流를 通해 相互協力 体制가 結束될 수 있는

것입니다.

우리나라는 過去 十余年間 年平均 10%以上의 높은 経済成長을 이룩하였읍니다. 이에는 国民의 높은 教育水準과 政府의 強力한 指導力이 決定的 役割을 하였읍니다.

그러나 経営, 行政의 合理化 내지는 科学化의 強力한 手段으로서의 運用科学의 役割도 無視할 수 없는 것입니다.

이제 韓国은 高度社会로의 成長에 迫車를 加함에 따라 経営의 科学化가 더욱 切実하게 되고 따라서 運用科学의 役割도 더욱 要求되고 있는 것입니다.

이러한 此際에 運用科学分野에서 国際会議를 開催한다는 것은 매우 意義있는 일이며 이는 太平洋地域 協力体制 強化에도 많은 보탬이 될줄 믿읍니다.

運用科学은 実際的 学問이고 따라서 理論의 開発도 重要하지만 이러한 理論들이 意思決定権者들로 하여금 自己의 決定에 対하여 責任을 지고 活用할 수 있도록 다듬어져 있어야 합니다. 그 理由는 아무리 그 効能이 認定된 理論이라 할지라도 自己가 理解하지 못할 때는 使用하지 않기 때문입니다.

이 大会 期間中 発表할 여러분의 論文이나 事例들은 바로 이들 意思決定権者들이 経営, 行政에 있어서 実際 当面한 問題를 解決하는데 많은 貢献을 할 것을 믿어 疑心치 않읍니다.

멀리 外国에서 오신 学者 여러분!

짧은 期間이지만 이 나라에 滞在하시는 동안 学術的 討論은 勿論이지만 오랜 歴史속에 만난을 극복하고 平和的인 삶을 追求해 온 이 나라의 여러面을 두루 살펴보시고, 特히 祖国 近代化를 追求하고 있는 生動하는 国民象을 보실 수 있기를 바라마지 않습니다.

아무쪼록 즐거운 時間을 많이 가지시고, 다시 韓国을 訪問할 機会가 있으시길 바랍니다.

本 大会를 為해 아낌없는 後援을 해주신 国際運用科学会聯盟과 本 大会를 主催한 韓国軍事運営分析研究会, 그리고 韓国運用科学会에 対하여 真心으로 致賀해 마지 않읍니다.

感謝합니다.

1979年 4月 23日

韓国科学財団 理事長

崔 亨 燮

CONGRATULATORY ADDRESS

by Dr. Hyung Sup Choi

Dr. Shim, Mr. Gratwick, Admiral Trost, Dr. Sperrazza, distinguished speakers, ladies and gentlemen!

It is a great pleasure for me to address and offer congratulations to the Pacific Conference on Operations Research. Although OR is a relatively new dicipline, we must give just credit to its great contributions in bringing about improvements in military, civil, and business management areas.

It is quite meaningful to convence this regional conference in Seoul now, because it is both timely and appropriate to increase cooperative development among Pacific countries. Our region is composed of many countries with unique characteristics -some are among the world's richest countries while others are still developing; a few countries enjoy abundant natural resources, while others strive hard to earn a living by increasing the value of materials bought from abroad.

Our histories, the origins of our cultures, and the characteristics of our people may differ, but we all share the common goal, for a rapid economic development.

Naturally the policies and methods for achieving a high economic growth rate differ among our countries, but an exchange of our differing experiences may well be worthwhile and rewarding. Through the exchange of ideas and experiences, one can learn from the failures and successes of others, and find ways for cooperative efforts that result in benefits for all of us.

In the past ten years, here in Korea we have achieved an economic growth rate of over 10% per year. This was made possible because the primary prerequisites were met- an adequate educational background of our people, and strong and stable leadership. Operations research methods have played a significant role in this progress and in the improvement of business management and overall scientific development in our country.

Operations research should emphasize the practical. It is good to develop new elegant theories, but it is more important to translate these theories into practical methods that can be used by these that bear the responsibility for making decisions. The decision makers may be reluctant to apply new analytical methods, no matter how effective these are touted to be, unless they fully understand the work of analysts, and have confidence in their methods.

I am confident that the presentations and discussions you will share during this Conference will help all of you in your search for solutions to the problems faced by the decision makers in your country.

To those who are here from abroad, I extend a specially warm welcome. I hope that you will take a good look at Korea while you are here, enjoy your stay, and decide to visit us again in the near future.

I would like to express my sincere appreciation to the IFORS for their support, and salute the members of KORS and MORS-K for their dedicated and successful efforts that have made this Conference a reality.
Thank you very much.

COMMUNICATIONS IN OPERATIONAL RESEARCH

JOHN GRATWICK

Vice President

IFORS

ABSTRACT:

O.R. has had a significant impact on business and military affairs, particularly in the industrialized countries. How this success can be replicated in the developing nations is one of the major challenges facing the O.R. profession. After describing a brief history of O.R., potential barriers to the diffusion of O.R. are highlighted with particular reference to the developing countries. Several crucial factors for the successful communication of O.R. are identified and discussed.

1. Introduction

According to Webster's New World dictionary the major characteristics of Communication include the act of transmitting; a giving or exchanging of information signals or messages by talking, gesturing, writing; a close sympathetic relationship; a means of communicating, specifically a system for sending and receiving messages and finally the art of expressing ideas especially in writing and speaking as well as the science of transmitting information particularly in symbols.

It is apparent that O.R. has been successful in a number of industrialized countries and this success has been dependent on effective communication. Whether it is possible to repeat this success in the developing countries is one of the major problems facing the profession.

Consideration of the origins of O.R., and its subsequent extensions will provide a base for considering its future prospects in both developing and developed countries.

O.R., like most successful products, should be expected to have a life-cycle, passing through the fairly clearly recognizable stages of market development growth, maturity and finally, decline.

In the West it has probably reached maturity, the third stage. Elsewhere, however, there is a sentiment that we are barely in the first stage, and that the potential for O.R. is still very great. To see if this potential might be realized a glance at a very abbreviated history of O.R. and the lessons that have been learned may show how this accumulated experience can best be communicated and used elsewhere.

If we look back to the beginnings of O.R. shortly before World War II the conditions then are analogous to those existing in many countries today. Of course, it can be argued that O.R's beginnings greatly predate World War II, but it was during that period that they became explicitly recognized.

2. The Beginnings - World War II

Radar was a new and largely untried form of warning against air attack. The German Air Force had great numerical superiority, and radar detection offered the British Air Force the only mechanism to redress this imbalance. The evaluation of radar and analysis of its impact on air operations brought into existence what we now call O.R. This exercise was the first 'conscious' activity of applying scientific thinking to tactical and strategic problems (in the theatre of war). While it was soon obvious that scientists, working closely with serving officers, could make a significant contribution to the decision making process, they only acted in an advisory role. The military officer, with his specialized training in leadership and command, still filled the role of management and decision maker. After the initial success analysing radar, other areas of operations were considered, and a major advance was the idea that O.R. might be able to predict the outcome of future operations and thus influence policy. It is worthwhile noting that from the outset the O.R. teams were multi-disciplinary in make-up, their analysis was done in or near the focus of operations, and done very quickly.

This was not only for security reasons, but also because of the nature of problems encountered. For example, members of the O.R. sections occasionally went on operational or training missions. The multidisciplinary team approach of problem solving utilized the concept of synergy, albeit in an unconscious way. In addition, it must be realized that there did not exist any methodological basis for tackling many of the problems which arose and disciplinary boundaries had yet to be created. It meant that a large pool of resources generated by the normal education system were tapped and used in a novel way.

It can be seen that O.R. in its beginnings was almost exclusively results-oriented; it made an immeasurable contribution to the outcome of World War II. In fact, 'the failure of the Germans to make use of

O.R.', wrote Professor Bernal[1] after the war, 'contributed to their defeat, both in their failure to find counters to enemy weapons and in expending disproportionate efforts on weapons which O.R. would have shown to be useless.'

3. Growth of O.R.

As could be expected, during World War II the practitioners had precious little time to make a conscious analysis of the methodology of their work or even to consider recording their experience in writing. The progress of O.R. during this period was very rapid and much greater than could be expected under anything but the most demanding and abnormal times. Initial successes in the analysis of radar and air operations led to the further demand for its application in the other arms of the services, in Britain, the U.S.A., and their allies.

At the conclusion of the war, O.R. in Britain and the U.S.A. took different paths. In Britain there was an immediate reduction in military expenditures as well as a pressing need to reconstruct the country's manufacturing facilities. This led to the release of O.R. workers into industrial and business organizations. In particular, there was a flow of personnel from the military to the nationalized industries such as coal, iron and steel, transport and other utilities. By contrast, in the U.S.A. defense spending was increased after World War II and thus O.R. workers in the U.S.A. stayed mainly in the military environment. Industry in the U.S. did not immediately perceive the applicability of O.R. to its activities. With the advent of commercially available computers and rapid economic expansion, the diffusion of O.R. personnel into industry happened at an accelerating pace only in the later 50's. In addition, consulting firms, universities, research institutes, and governmental agencies built up an O.R. capability which in turn put additional pressure on industry to make use of these new skills.

The acknowledged and publicized success of O.R. in World II, together with rapid growth, also encouraged

many businesses to look for alternative methodologies in their quest for superior performance. O.R. offered part of the answer. Its capability to solve tactical problems had been well proven and comparable issues of this nature were identified. As might be expected, much O.R. methodology became explicit and theoretical research led to major developments, including mathematical programming, game theory, Monte Carlo simulation, queueing theory, network analysis and CPM. The formation of national societies was encouraged, journals emerged, books and articles were published and formal courses at universities were established.

One interesting observation is the diversity of subjects and functional areas discussed in the literature. Moreover, both the professional publications and national societies have encouraged the extension of O.R. effort not only in their home countries but elsewhere. In this way the professional organizations continue to play an important communications role in the diffusion of O.R.

Therefore, by the mid-60's, a large body of knowledge and theory had been constructed which has made extremely valuable contributions to industry, transportation, utilities, government agencies and many other areas. Although still primarily tactical, we can consider O.R. as having reached a fair stage of maturity.

4. Maturity

For some time past, there has been a growing recognition of O.R.'s limited contribution to larger social issues and world affairs. This is particularly true as far as success in the larger strategical-type problems even through significant work has been done in the field of military strategy. In fact, as early as the mid-60's, there was evidence that some O.R. groups were facing diminishing returns in industrial applications. Further, the majority of published papers appears to be becoming more and more abstruse and divorced from reality as time passes. Such "pseudo" sophistication alienates both the O.R.

practitioner and decision maker, and is having a regressive impact on O.R.'s extension and development.

Presently there appears to be a complete dearth of new approaches with which to tackle some of the more pressing problems facing the developed nations. This feeling of dissatisfaction with the current status of O.R. has been described by Lee[2] in 1976:

"There is no doubt that operational research has diffused into new fields of application during the past seven years. The extent of this diffusion, has however, been less than the increases in the number of the institutions of operational research and their size would suggest. The evidence of surveys, of journals and conferences is that intensification - more people doing the traditional kinds of operational research in the traditional fields - has been much more marked than diffusion. There are, I think, many reasons for this, but the most significant, in my opinion, is that for years operational research has been living on its intellectual capital. The amount of geniune research - the creation of new ideas, new perspectives upon some significant aspect of the behavior of complex socio-economic systems or the development of powerful new techniques in operational research has been trivial".

And, more recently by Morse[3] in 1977.

"The pages of Operations Research seem more like advanced mathematical texts, than like those of journals of physical science".

It would appear that O.R. is presently at a very critical stage of its life-cycle. While it may be premature to assume its decline is inevitable, the possibility is very real. Just as O.R. came to life under cataclysmic circumstances, however, so may similar situations in the developing countries encourage a re-birth of O.R. globally.

5. O.R. in Developing Countries

Introduction

Although it appears that the development of O.R. in the West has stopped, the field of prospective O.R. applications elsewhere is much more fertile. It seems evident, however, that the most important problems facing us are just those that O.R. in the west has been singularly unsuccessful in addressing, e.g. food shortages, materials and energy management, justice, government and the quality of life generally. If we think back to O.R.'s beginnings, we see that O.R. is or should be much more than its methodological labels. It is essentially a process or attitude to problem solving that uses what is available or invents when necessary. Thus, if O.R. is to continue to be a living and growing intellectual endeavour, we must continually address new problems like those in the developing countries. In this way we may be useful to them, as well as stimulating a renaissance of O.R. in the West.

If the quantity of publications is any measure, O.R. in the developing countries is still at the first stage of its life cycle. There have, however, been several notable attempts to expedite this process, including the IFORS '75 Conference in Tokyo.

The O.R. work to-date in developing countries has concentrated, with few exceptions, on approaches using traditional and standard techniques, with a heavy reliance on computers. In several developing countries O.R. has been practiced for a number of years. For example, O.R. was formally introduced into both Egypt and Peru by the late '50's although traditional industrial engineering was common much before then. The pervading philosophy for this approach was that since a method had been successful in one country, it would naturally also work elsewhere. This seems to have resulted in little but a relative lack of acceptance. While there has been a considerable discussion as to the reasons for failure, and some prescriptions (Elshafei (6) and Sagasti

(7)) for success, little real progress has been reported. It seems to me there are several factors that may explain why O.R. has not lived up to its potential.

O.R. came to fruition as a result of World War II in an operating environment where the cultural, social and political impacts were largely irrelevant. They were not consciously considered until much later, and belatedly, in the developed countries. They are responsible for a number of impediments to successful communications and transfer of technology, and are of particular concern where ideas and concepts form the substance of what is to be transferred.

6. Social Barriers

In any society the local value system not only helps determine what may be done, but because of its pervasive influence may affect what can be done. For example, some societies place greater emphasis on avoiding failure rather than on rewarding creativity.

In other countries, even significantly greater financial rewards are insufficient to encourage people to change to work that appears to them to be socially unacceptable.

The economic system (or lack of it) in some countries can have a tremendous impact on the transfer of technology and there will be usually a paradoxical combination of both stimulus and restraint. One of the factors which accelerates the adoption of new technologies is the sheer growth in the size and complexity of organizations. Once a company gets to such a size that it cannot be controlled by a family or small group then professional managers will be obligatory. These managers may then introduce new technology in anticipation of achieving a multiplier effect on the available, limited resources.

On the other hand there are economic factors which inhibit the use of new technologies. Competition may be limited in the interests of protecting domestic

industry. Some cultures place little value on labour efficiency since they are labour-rich. In India the Government has restricted the supply of computers because of the genuine fear of massive unemployment resulting from the displacement of clerical labour. A final, obvious point is the scarcity, or even absence, of owners or managers with the social and educational background that allows them to accept and introduce rapid changes.

Personal relationships can also influence the technology transfer intimately because in an industrial environment group relationships are critical. Each society has its peculiarities which stem from many sources - social and family customs and methods of education. Some emphasize the individual while others stress group activity and achievement, or strong family relationships and responsibilities. In Japan, the religious emphasis on the importance of family and ancestry has been carried over into the economic enterprise, with a beneficial impact on productivity and worker cooperation.

A final aspect of social systems is that of organizational relationships. That is, the way groups of people interact with each other; whether authority or collaboration is used to resolve conflict; whether communication among departments is formal or not.

Social factors, if they are ignored, will in many cases, lead to the rejection of the technology. In fact, Ackoff[4] goes so far as to suggest that corruption, time-wasting and paternalism should be tackled first since these are the major obstacles to transferring a soft technology like O.R.

7. Cultural Barriers

One of the most significant aspects of culture, as is abundantly clear to us in Canada, is language. O.R. was developed in an Anglo/American environment and as such the language of communication was English with all its subtle, concommitant cultural attachments and an implicit value system. Elsewhere, even though

English may be spoken by a large proportion of the population, it may not be the language of cultural communication. In India, Hindi is a national language and is perfect for describing the traditional culture. It cannot, however, give adequate expression to modern industrial activities, so English has to be used for this.

Therefore, in the diffusion of O.R., in English, there may be barriers to communication implicit in its language. These barriers involve elements of semantics, perception and linguistics. We all know how difficult it is to work through an interpreter even when the exchange is between people with comparable backgrounds.

In anything except the hard sciences, words can be considered as symbols which induce a reaction which varies both with the hearer and with the context in which they are used. There exists the possibility of an indeterminate number of variations to a spoken word. With the hard sciences because of their greater rigour and, more importantly the ability to express meaning and relationships in mathematical terms, the possibility of misinterpretation is reduced.

Perception, on the other hand, strongly influences what we say and hear. It varies according to many factors, including the environment and background. Although part of the same company, labour and management do not "see" the world in an identical fashion. In addition, nationality, functional importance, and experience can affect perception. Contrast the ways the French discipline their children with the Germans or the English. The English tell naughty children to be 'good', the French say be 'wise' and the German, 'get in step'. Functional importance may best be illustrated by noting that in the northern part of my country, Eskimos have no single word for "snow" although there are a number of different words each describing precisely an exact snow condition. Anyone wishing to communicate must first be able to recognize the subtle variations in snow conditions. Some people

perceive minute differences that are not visible to others for whom the differences are less important. Finally, it is clear that past experience acts, mostly subconsciously, as a filter. In poor light conditions Westerners perceive a trapezoid as a rectangle (based on a conception of a right angle culture) whilst many Africans perceive the same drawing, correctly, as a truncated cone.

Linguistics can be crudely defined as the effect of language patterns on what is perceived. Different languages cause their users to distinguish experiences differently and categorize their perceptions in different ways. One often hears bilingual and multilingual people saying how they become a different person with a changed personality when they communicate in different languages.

Body language, or kinesics, is another important aspect of communication which again varies according to nationality, even among those with the same spoken language.

Language is the most obvious difference between cultures and is central to the understanding of any country's culture. Many other elements are relevant, however, and include aesthetics, education, religion, beliefs and attitudes, family and political life. In one form or another they have considerable impact on the communication and transfer of technology and are the source of many of the difficulties.

8. Political and Religious Barriers

The impact of the political environment on technology transfer tends to be given the most attention, and as a result is generally seen as a major barrier. The forthcoming United Nations Conference on Science and Technology, to be held in Vienna next September, seems to be focussing much of its attention on the topic. What tends to be overlooked is that the actual environment in which O.R. work is conducted is not simply a reflection of the national politics of the country. It is an amalgam of national, local and institutional politics, generally with a dash of

religion mixed in. Success depends on acquiring a feeling for the net effects of the particular mixture, and being responsive to them, rather than accepting global labels. Capitalistic economics, relying on the Protestant work ethic, may well find a comfortable niche in the most egalitarian of communes.

9. Effective Transfer of O.R.

Before the diffusion of O.R. to another environment can happen effectively there must be some prospect that change will be accepted. This is most likely in areas where there is a perceived and real need. This probably means addressing problems concerned with food and population, environmental quality, energy management, economic development, the quality of life and possibly transportation.

That O.R. could aid in these areas, especially in developing countries, seems almost a truism, especially as O.R. is basically aimed at improving the existing order of things. This sentiment was expressed by Morse and Brown (5) at the IFORS Conference in Tokyo, 1975, but I would also advocate Morse's more fundamental operating philosophy that "if we stick to our original aim of matching our models to reality, rather than trying to make reality fit the prepared model, we can contribute in important ways to many of the serious problems of the world". (3)

This, to me, means building on a core of ideas much like those originated during World War II where the emphasis was on using simple, but unfamiliar, logical models to analyse the structure of a problem. This is not a reactionary view, nor am I decrying most recent advances. I am simply stressing the worth of the O.R. process as opposed to its manifestations. This implies that the concept of optimality in the traditional sense may only rarely be pertinent and that relying on the application of a proven technique will not contribute very much.

The economies of many countries are characterized as being still largely agricultural, suffering from acute shortages of capital and technical and managerial expertise, and very vulnerable to the external environment. In addition, conditions are often changing rapidly and unpredictably. This affects both what can be done and what has some prospect of remaining relevant for any length of time.

The most severe constraint to economic development is one of a shortage of skilled manpower. Initially, this expertize can be imported, but in the longer run, success or failure will depend solely on the peoples of the country and their own efforts. In turn, this implies the need to expand educational facilities that can develop the indigenous competence needed to manage the country's affairs.

In a constrained and frugal environment only robust approaches to problems will have a chance of being accepted and understood, especially if literacy is a problem. Illiteracy makes even a most progressive man very conservative - he can only stick with the methods he knows and can remember.

Robust methods are also pertinent because often there is rarely time to gather data (even if it is available) and carry out a detailed study before a decision has to be made. The problem then becomes one of trading off the cost of delay against that of sub-optimization. There is considerable relevance to Schon's argument that "the life of solutions to most critical social problems and organizational problems is shorter than the time required to find them. Therefore, more and more optimal solutions are stillborn. With the accelerating rate of technological and social change...., the expected life of optimal solutions and the problems to which they apply can be expected to continue to decrease". (8)

It would also seem that the 80/20 rule may also be pertinent - the first 20% of the effort or money or time spent on a project usually results in 80% of the customers' satisfaction with the work. Acceptance of

this philosophy would certainly improve the O.R. professional's utilizaton of his time. Even rough approximations often yield dramatic improvements.

In general, most of the 'advanced' standard techniques will not be readily applicable for several reasons, including an unsophisticated infra-structure and lack of access to an adequate computer (currently our chief prop and source of comfort). Most importantly, there will be insufficient justification for the marginal improvements that these techniques are designed to produce.

10. Group Composition

I believe that the O.R. process is best characterized by multi-disciplinary team composition, and this offers the greatest likelihood of success with problems that are largely unstructured. It may even be a trifle platitudinous to talk of a multi-disciplinary group, just as it would be to call for individuals of high calibre. It may be more relevant to say that the people in an O.R. group should offer a range of quite different backgrounds and experience, and that they should have that melange of analytical curiosity and iconoclasm that seems to have been common to many of the early practitioners.

In addition, local talent should be used as much as possible. People already involved have special expertise and are likely to be affected most by the study. By making local people part of the group, the value of team work can be illustrated, and some of the ideas generated may take root. It is particularly important to choose the most appropriate people. Marketing experts have classified farmers into five major categories: innovators, early adopters, early majority, late majority and laggards. The critical group is the second one - early adopters. Treating O.R. as the product, identify this group and concentrate on communications with them. Project leadership is always important. This leadership should, preferably, come from within the country but initially this step often needs the catalytic assistance of an outsider. NATO and IFORS,

for example, are already attempting to provide help in this manner. Countries and organizations with longer experience must be encouraged to contribute assistance, perhaps through a mechanism similar to the university sabbatical. While they were often misunderstood and maligned, the techniques and approach of the religious missionaries made them effective communicators of novel and sometimes dubious ideas, and they provide us with a very suitable model.

Developing the awareness and understanding of the decision makers is of equal importance to finding solutions. Tackling a diversity of projects, with differing levels of importance and interest, is a sounder approach than sinking everything into one large, high profile effort.

11. Conclusions

I have attempted to link the problems of communicating OR to both its past history and its present environment. OR can be successfully communicated if the message concentrates on the fundamentals, and if sufficient attention is paid to identifying the barriers, constraints and distortions that may limit the transmission of the message.

Conferences such as this one are, of course, a means of communication. I have tried to live up to my own precepts today, but I am very conscious of the fact that, while it may be more blessed to transmit than to receive, transmitting is by far the easier part.

REFERENCES

1. J.D. BERNAL, "Science in History", pp. 581, Watts.

2. A. LEE, "The Relentless Ambush", INFOR 14, 1976, pp. 279-287.

3. P.M. MORSE, "ORSA Twenty-Five Years Later", Op. 25, pp. 186-188.

4. R.L. ACKOFF, "National Development Planning Revisted", Op. Res. 25, pp. 207-218.

5. P.M. MORSE & A.A. BROWN, "Operations Research in the Developing Countries - a role for IFORS", K.B. Haley, ed., O.R. '75, North-Holland Pub. Co. (1976)

6. A.N. ELSHAFEI, "O.R. in Developing Economice: Serve experience with applying O.R. in Egypt's National Planning Studies", K.B. Haley, ed., O.R. '75, North-Holland Pub. Co. (1976).

7. F.R. SAGASTI, "Use of OR/MS", Op. Res. O., Pergamon Press 1976, Vol. 27, 4, ii, pp 237-248.

8. D. SCHON, Beyond the Stable State (Random House, New York, 1971).

THE ROLE OF OPERATIONS RESEARCH/SYSTEMS ANALYSIS IN DEFENSE POLICY AND PROGRAMMING DECISIONS

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The very fact that so many of us are here to participate in this conference on Operations Research is an indicator of the importance we attach to this relatively new and still expanding field. All of us recognize that Operations Research techniques are especially useful tools in problem solving in business, Government and the military. A discussion of the role of Operations Research and the related field of Systems Analysis in national defense policy and programming decision processes seems especially appropriate at the opening session of this conference. As you know, Operations Research as an organized form of research first found application in the review of individual military weapons systems and their effectiveness just over forty years ago. From that relatively narrow beginning has evolved a discipline whose future exploitation and utility you will explore over the next several days.

I plan to review very briefly the historical development of Operations Research and Systems Analysis as tools in the defense decision-making process. Then, I will give you an overview of their application to today's military and defense problem solving by discussing the use of these techniques at the headquarters level by the United States Navy. Obviously, in such a brief period, I cannot cover all applications, specific techniques, or all of the groups involved in such a complex process.

A review of the historical development of Operations Research/Systems Analysis reveals that the use of the basic concepts of Operations Research is not new; it originated with the first attempts to use the scientific approach to solve problems. We are still seeking, through modern analysis, to answer the three questions posed by John Dewey in his examination of the problem solving process in 1910.[1]

- What is the problem?

- What are the alternatives?

- Which alternative is best?

As I noted earlier, Operations Research, as an organized form of research, began in Great Britain in the late 1930s with the review of individual weapons systems.

- In 1937, civilian scientists, under the leadership of Sir Robert Watson-Watt, were hired to teach British military personnel how to use the newly-developed radar to locate enemy aircraft.

- By 1939, at the outbreak of the war in Europe, Britain had the nucleus of an Operations Research organization. As the war progressed, the size and scope of the staff expanded. This staff represented many disciplines- Physical Sciences, Mathematics, Statistics, Biology, Physiology and others.

- By 1941, the British Operations Research group included American scientists who later performed Operations Research for United States military forces.

Because of the urgent need to effectively resolve a number of strategic and tactical problems and to provide a basis for decision making, the research conducted by this group was broadened to include almost every phase of military operations, including convoy, anti-submarine warfare, anti-air warfare and even civil defense operations. The research on (military) operations gave rise to the name "Operations Research" (A name Sir Watson-Watt claimed to have originated).

Following the British lead, Operations Research groups were established in Australia, Canada, and the United States.

The first Operations Research activity in the United States was formed in March 1942 at the Naval Ordnance Laboratory. It was concerned primarily with mine warfare; its work culminated eventually in the aerial mining of Japanese-controlled waters from Singapore to the Japanese home islands. The establishment of this group was the beginning of a rapid growth of Operations Research activity in the U.S. Navy.

By mid 1942, the U.S. Air Force, then the Air Corps, also formed a prototype group, and, by 1945, had 26 Operations Research groups with over 400 officers, enlisted personnel and civilian analysts.

The U.S. Army did not make as much use of Operations Research, but by 1944, it did have a few evaluation groups, primarily concerned with operations in the Pacific.

At the end of World War II, many U.S. military Operations Research groups disbanded, but some were retained or reorganized. A number of former military analysts began using their skills in Government and various civilian organizations. The adaptation of Operations Research techniques to the analysis of business operations caught on quickly, for in a highly competitive economy, there is strong impetus to make business and industrial operations more efficient, and thus, more profitable.

For the U.S. military, there were new problems which emphasized the need for the continuation of Operations Research efforts. It didn't take long for quantitative analysis to become institutionalized within our Department of Defense. The Navy expanded on the existing Operations Research Program. The Army created the Operations Research Office, administered by Johns Hopkins University, and the Air Force was instrumental in the establishment of the Rand Corporation. Rand's efforts to relate Air Force needs to budget allocations and to fashion strategic concepts led to use of another concept, Systems Analysis.

Let me turn to definitions for just a moment. The difference between Operations Research and Systems Analysis is one of emphasis. Operations Research is used to find optimum ways to use the resources available to solve the operational problems encountered. Operations Research techniques are usually applied to the solution of well defined problems. Systems Analysis, on the other hand, is somewhat less technically oriented and deals with problems of greater complexity and more uncertainty. It looks at solutions that might not take effect for several years, dealing also with overall direction rather than with the details of near-term operations. Systems Analysis takes problems that are not defined and attempts to define them. Systems Analysis has been said to relate to Operations Research as strategy relates to tactics. On the other hand, a classic definition of Operations Analysis (as opposed to Operations Research) is "a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control."2

It was not until the early 1960s that Systems Analysis came of age in the United States Department of Defense. In January 1961, Robert S. McNamara became Secretary of Defense and introduced into the highest levels of the defense decision process the analytical techniques which the

military services themselves and their research groups had pioneered. He named Charles Hitch, a noted economist and Rhodes scholar, to the post of Defense Comptroller. Hitch was to initiate major innovations in defense planning, including heavy reliance on the techniques of Systems Analysis. In April 1961, Hitch appointed a young economist, Dr. Alain C. Enthoven, to head the Systems Analysis Office under the Deputy Assistant Secretary of Defense for Programming. In 1962, Enthoven was assigned the new post of Deputy Assistant Secretary of Defense for Systems Analysis, a recognition of the importance Secretary McNamara attributed to this capability.

The use of Systems Analysis in the Department of Defense had changed since first introduced by Secretary McNamara. During the McNamara era, the Office of Systems Analysis primarily originated studies and recommendations and reviewed proposed forces and programs. It now tends also to examine broad strategic and economic problems while still paying attention to the details of weapons selection. The Department of Defense Systems Analysis Staff is now designated as the Office of Defense Program Analysis and Evaluation.

With that historical background in mind, I will now move to an area I am most familiar with and the main section of my remarks- Operations Research/Systems Analysis in the U.S. Navy, and its role in the decision-making process.

At the center of the Navy's in-house headquarters level Systems Analysis and Operations Research capability is the Systems Analysis Division of the Office of the Chief of Naval Operations, an organization which I headed for two and one half years prior to assuming my present assignment. The role of this organization goes beyond the specific applications of Operations Research and Systems Analysis techniques, but, nonetheless, the tasks assigned are indicative of contributions made by these techniques to the decision process. The Systems Analysis Division is one of three divisions- a Program Planning Division and a Fiscal Management and Budget Division being the other two- which are directly subordinate to the Director, Navy Program Planning, a senior Vice Admiral who is responsible for supervising and coordinating the entire Navy program planning, budget and study effort. His office must ensure that the functions of planning, programming, budgeting and appraisal are integrated to achieve a balance of individual programs which lead to a balanced Navy.

Maximum current and future capability and effectiveness within given fiscal constraints are the principal goals.

The Navy's Systems Analysis Division was established in 1966, a relatively recent addition to the headquarters organization supporting the Chief of Naval Operations. It was established in order to provide the CNO with a direct capability to evaluate specific Navy programs and to examine the effectiveness of alternative programs and proposals. It plays a major role in long-range mission and program evaluation and forecasting, in resource allocation and program formulation, in providing an ongoing overview and critical analysis of the progress of new systems developments and in providing background information for policy level decisions. The Systems Analysis Division is a highly effective and responsive organization which performs a vital role for our Navy. It generates within the Navy a better understanding of actions necessary to meet competing requirements and provides effective presentations of requirements and program alternatives to senior decision makers.

The Division maintains a close liaison with the Program Analysis and Evaluation Office in the Office of the Secretary of Defense. It works closely with the other divisions in the CNO's organization in coordinating the overall Navy program planning and study effort. The Systems Analysis Division coordinates and assists in analysis work conducted in other Navy staff offices, as well as in supporting organizations throughout the Navy.

The formal statement of responsibility for the Division enumerates some forty-five functions which are carried out by the Division. In addition to the liaison and assistance mentioned above, the Division is involved in such tasks as:

- Evaluating the requirements of current and future Navy and Marine Corps missions and assessing our capability to meet assigned tasks.

- Determining programming actions and new capabilities required to improve mission performance and capability, including necessary force levels, mix of forces, specific weapons systems and personnel and support requirements.

- Defining planning, programming and policy issues which must be resolved in order to provide for a balanced and capable force.

- Developing, reviewing, and refining computer war gaming models. War gaming techniques are applied to the analysis of naval warfare tasks and associated tactics and weapons systems.

- Assessing the threat to the ability of the Navy to carry out its mission, including identification of options for meeting this threat.

- Carrying out studies that analyze and validate functions such as costing, production schedules, and contract performance of Navy programs-with emphasis on major weapons systems.

- Acting as central coordinator for the Department of the Navy Studies and Analysis Program.

The Navy's Operations Research and Analysis Program is also supported strongly by groups in headquarters support and field organizations. The efforts of these groups are tailored to support the missions of their parent organizations and are usually directed to the solution of problems in specific mission or weapons systems areas.

Key among the Navy's analytical support organizations is the Center for Naval Analyses, an independent non-profit civilian organization operated under contract in support of the Navy's total studies and analysis effort. This organization provides a dedicated, highly professional group of analysts with a capacity to undertake comprehensive analyses of a broad range of military issues, policies and problems.

Although CNA was not established until the early 1960s, one of its major components, the Operations Evaluation Group (OEG), is a lineal descendant of one of the first Operations Research groups organized by the Navy during World War II. The early recognition of the unique value of the ability of an organization like OEG to provide an independent, unbiased, scientific viewpoint paved the way for general acceptance of Operations Research/Systems Analysis techniques throughout the Navy.

CNA provides Operations Research in support of the Navy in a variety of ways. Its work includes considerations of both narrow and immediate as well as the very broadest long-range problems of the Navy. Representatives of CNA work throughout the Navy, with major force and fleet commanders, with units such as experimental aircraft squadrons, as well as in the Office of the Chief of Naval Operations (OPNAV) on major studies. CNA's work for the Navy is coordinated through the Systems Analysis Division.

Several conditions are essential if an Operations Research or Systems Analysis organization is to be an effective and credible contributor to any decision making process. The group must have.

- The necessary personnel, properly trained, qualified and motivated.

- The freedom to operate objectively, honestly and independent of any outside influence. There can be no directed answers or preconceived solutions.

- The group's leader must have direct access to senior decision makers for consultation, guidance and presentation of results.

These conditions have been met and are major contributors to the United States Navy's effective and highly responsive Systems Analysis organization.

The mix of personnel and their backgrounds and qualifications vary with the organization. In the Center for Naval Analyses, civilian professionals outnumber the naval officers by about six to one. These civilians are men and women with advanced degrees in one or more academic or technical fields; many have long years of practical experience in their fields. They have an established reputation for independence, objectivity and credibility. The naval officers in their midst ensure full and accurate military input to studies and analyses. These military officers, and their fellows in the Systems Analysis Division, represent the full spectrum of academic and professional backgrounds. All warfare specialties and supporting staff disciplines are represented. Especially valuable are those officers with a strong operational background - men who know the fleet, the ships, the aircraft, the submarines, the weapons systems, and who also

know intimately the environment in which our equipment operates and where our personnel work and live. The majority have graduate degrees; at least half have an advanced degree in the field of Operations Analysis. Of greatest importance, however, is the fact that each was selected for his current assignment on the basis of sustained superior professional performance and academic capability.

Our naval officers gain their Operations Research/ Systems Analysis training primarily from two sources. One source is at the undergraduate level. Since 1959, a naval Operations Analysis course has been taught to prospective officers at the U.S. Naval Academy. This course does not be any means produce experts, but it does enable our future officers to have a familiarity with the subject early in their career. Other officers major in this field in our civilian universities. The second source, and the most valuable one, is the graduate program in Operations Analysis which has been taught at the Naval Postgraduate School in Monterey, California, since 1951. This program produces a trained officer who is an immediately usuable asset to the Navy. Officers graduating from this curriculum alternate assignments to operational billets with those jobs requiring a sub-specialty in Operations Analysis. The program has an outstanding reputation-a reputation that has been enhanced under the able direction of Dr. Jack Borsting (Provost and Academic Dean) and Dr. David Schrady (Dean of Academic Planning and Dean of Information and Policy Sciences), both of whom have had a long association with national and international Operations Research and Systems Analysis organizations. The Naval Postgraduate School maintains a military viewpoint and provides the student with a thorough survey of tactical, strategic, procurement and weapons-system problems.

Personnel in our Navy Operations Research and Systems Analysis groups are guaranteed the opportunity to do their work as objectively and independently as possible. The President of the Center for Naval Analyses is guaranteed independence under the terms of his contract. In the Navy, he reports directly to and responds only to the guidance of the Director, Systems Analysis Division and to his immediate superior, the Director Navy Program Planning. These two officers, in turn, enjoy direct access to the Vice Chief and the Chief of Naval Operations, thus

guaranteeing their freedom from any attempts at undue influence on the part of other staff officers.

CONCLUSIONS

If my presentation has sounded like a sales talk, in a sense, it is. I believe a viable analysis program is a valuable management tool for almost any large organization military, Government, business or industry. Definitive analysis is essential in the defense decision making process, just as it is in an enterprise where the bottom line is profit or loss. For the U.S. Navy, as with any military organization, analysis techniques provide an invaluable means for insuring that we effectively use the assets available under given fiscal or other constraints. But, some words of caution:

- Operations Research/Systems Analysis is not decision making itself; it is simply a tool to be used in the decision making process.

- Analysis guides and assists but does not dominate defense policy and programming decision.

- It is one of several, albeit, a very valuable tool which is useful to the decision maker.

In the final analysis, decision making is based on judgment- with the person making the decision weighing all factors and information available and applying knowledge gained through experience in order to reach the best possible solution or decision.

REFERENCES

(1) Dewey, John, HOW WE THINK, 1910

(2) Morse and Kimball, METHODS OF OPERATIONS RESEARCH, Mitt Press, 1951.

REALISM IN MILITARY OPERATIONS RESEARCH

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1. INTRODUCTION

REALISM in any endeavor is a critical input. In our profession, MILITARY OPERATIONS RESEARCH, it is the most critical input. I want to emphasize, unequivocally, the requirement for realistic input data. During these sessions, you will hear much about operations research and system analysis techniques, but I suspect there will be very little on data collection, input data and validation of results. Without these elements, OR/SA may be a dangerous tool and can promote many poor decisions. The requirement for realistic input data is paramount to the success of the OR/SA community.

Let Us Look at the History of Our Profession. In the beginning OR/SA was called operational research. Initially, British operations research in World War II was on radiolocation. The early OR community in Britain had a distinct advantage over the OR community of today. They had immediate feedback on their analyses, and the opportunity to compare analytic results with actual real world results. They did not have the luxury of sophisticated methods and computer techniques available today, but they made extensive use of real world data in their analyses. Are we doing that today? I am convinced that the present OR/SA community is overcome by the sophisticated methods and computer techniques available today and doesn't place enough emphasis on the use of real world data.

2. MILITARY REQUIREMENTS

Why Do I Feel This Lack of Realism? Let me discuss several examples that I feel illustrate the necessity to return to the data collection, review of input and validation phases of OR. The first area concerns OPERATIONAL REQUIREMENTS. In the U.S., as in most of our countries, the development programs are based on operational requirements formulated by the Military branches.

An example of a critical requirement is mean time between failure (MTBF) for the system. When we applied OR/SA techniques to three different systems under development (a radar, an engine, and a helicopter) we soon recognized that from an operational point of view the original requirements were much too stringent.

TABLE 1. MEAN TIME BETWEEN FAILURE REQUIREMENTS

SYSTEM	MTBF (HOURS)
Air Defense Radar	600
Engine	1200
Helicopter	75

In the case of the air defense radar, the original MTBF was established without analyzing the operation mission and the realistic engagement requirements. An effort was undertaken to analyze the probability of the system being available as a function of attack time of enemy aircraft and the system MTBF. Given a failure occurred, various repair times were also analyzed. Figure 1 shows that the original MTBF requirement of 600 hours was not required.

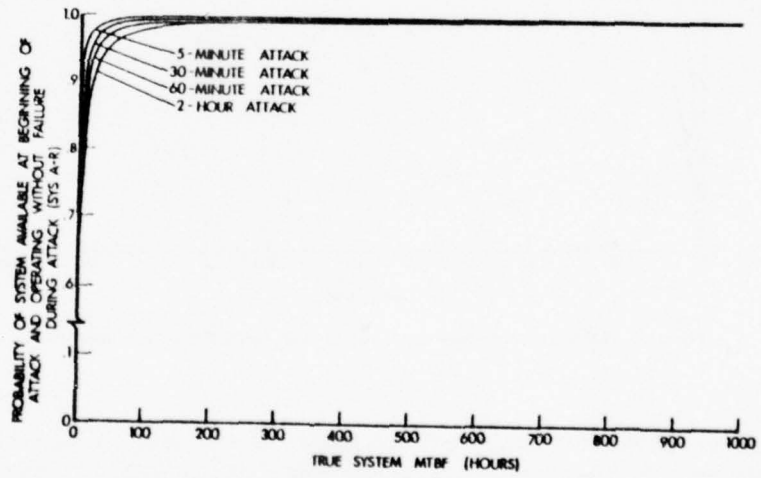

Figure 1. Effect on Air Defense Radar Availability-Reliability of Varying True System MTBF for Various Attack Times (30-Minute Repair Time).

The requirement stated for the engine directly impacted on the expected MTBF for the helicopter. When test results indicated that the engine could not meet the 1200 hour requirement, the logical question was how would a change in the engine requirement influence the availability of the aircraft for realistically defined missions.

AMSAA initiated an effort to analyze the mission of the helicopter. Based on analyses of many mission scenarios, it was determined that the maximum duration of any mission was about 3 hours. Figure 2 shows the probability that an aircraft is available and successfully completes its mission as a function of the MTBF of the aircraft. Significant for the one and three-hour missions is that a reduction of the original 75-hour MTBF for the helicopter is not very critical.

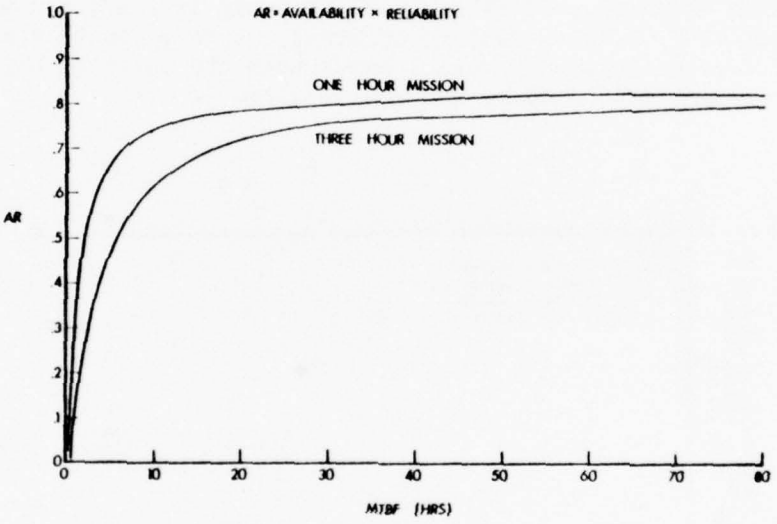

Figure 2. Probability Helicopter is Available and Successfully Completes Mission.

The interrelationship of the MTBF of the engine and helicopter was further analyzed since the engine was not meeting the requirement. Data from the testing of the helicopter system indicated that the MTBF of the system less the engine was 86 hours. Taking this into account, the data in Figure 3 were developed. The significant point here is that the system MTBF being reduced to 50 hours, could be met if the engine were to achieve approximately 200 hours MTBF. The

test results for the engine showed it could easily meet this requirement and could be changed without impacting total system availability (Figure 2).

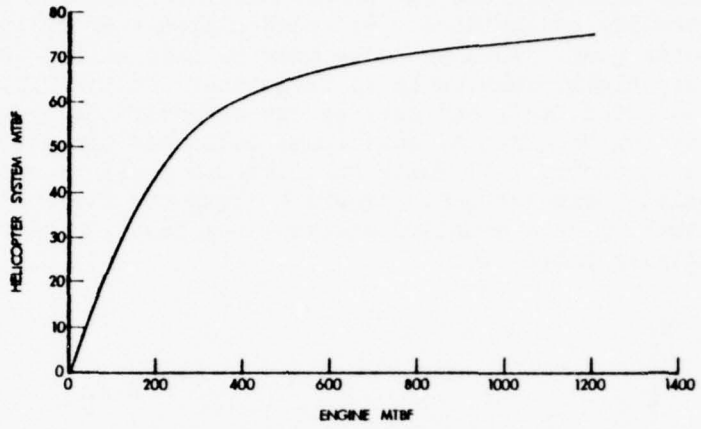

Figure 3. Helicopter MTBF Less Engine MTBF = 86 hrs.

The overall result of these analyses was a change to the stated requirements as shown in Table 2, and elimination of further development and testing to meet unrealistic requirements. These are only a few examples of where military OR/SA has and can influence requirements. I urge each of you to increase your study efforts to influence this most critical phase of military development.

TABLE 2. MEAN TIME BETWEEN FAILURE REQUIREMENTS

System	MTBF (Hours) Original Requirement	Modified
Air Defense Radar	600	200
Engine	1200	400
Helicopter	75	50

3. SURVIVABILITY

Another example, again with electronic equipment, where OR/SA has been applied, but unsuccessfully, concerns the survivability of shelters. We spend millions of dollars on electronic gear. Then we house them in thin walled shelters which are highly vulnerable to fragments. In the U.S., we have conducted tests and carried out extensive analyses to quantify the benefits of additional ballistic protection. We have conducted full scale verification tests to support our analytic conclusions. Figure 4 shows the improvement in survivability of a standard shelter as a function of weight of ballistic protection.

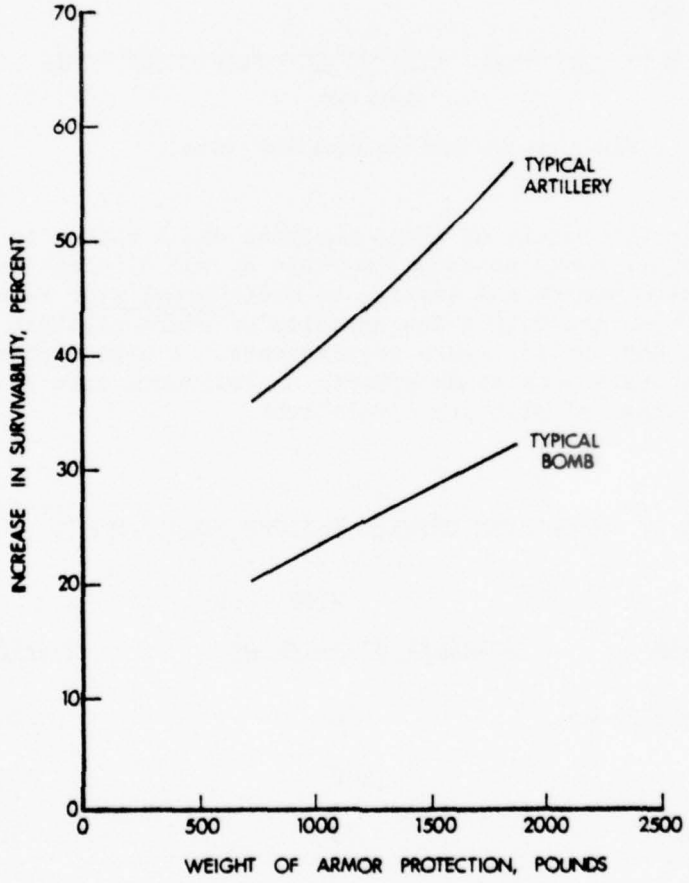

Figure 4. Survivability Increase in C^3 System Hardened Shelter.

I raise this case because I feel this type application of simple, straight forward OR/SA supported by realistic data offers tremendous opportunity for future success as new equipment becomes more expensive, more complex and requires longer development cycles.

I cannot stress too strongly the need to address survivability. OR/SA can provide significant guidance and insight in this area. We can identify realistic ways to improve survivability through equipment modifications and tactical usage. I urge you to accept this challenge.

4. WEAPON DESIGN AND EVALUATION

Now let us address the area of weapon design and evaluation. In the U.S. we have two general classes of targets - air and ground targets. As one might expect, the design, development and estimated utility of weapons are very much a function of the defeat criteria. I question how <u>realistic</u> our kill criteria are.

In the case of air targets we have several criteria, but the two most widely used are:

<u>A-Kill</u> An aircraft falls out of manned control in less than 5 minutes.

<u>K-Kill</u> An aircraft falls out of manned control in less than 30 seconds.

These criteria were developed after World War II to allow the OR/SA people to conduct vulnerability assessments. There was little consideration given to the realistic battlefield environment, the threat and desired results. These criteria have been used for over 30 years to compare the relative effectiveness of systems.

However, when these criteria start to dictate design of weapon systems, I become alarmed. Usually we state a requirement for a K-Kill at long ranges for an air defense gun which leads to a large caliber system. It is driven by the desire to produce a K-Kill before an enemy aircraft can drop its ordnance.

An investigation of combat data indicates that aircraft attacking ground targets, need not be catastrophically destroyed. We point out that the mere presence of air defense guns, degrades delivery accuracy of air delivered ordnance and also results in aircraft damaged that do not

return. Table 3 shows the relative accuracy of air delivered ordnance experienced by the U.S. in Vietnam for no air defense, light and heavy defends. The degraded accuracy has a significant effect on the damage level produced.

TABLE 3. ACCURACY OF AIR DELIVERED ORDNANCE

Air Defense	Relative Accuracy
None	1.0
Light	1.5
Heavy	3.1

Of equal or greater importance is the fact that aircraft that are hit, but not necessarily killed, have difficulty in completing their mission, and require repair time. In Vietnam we found that of the aircraft hit by 23mm and 37mm projectiles and not killed, over 50 percent aborted the mission. For some aircraft hit that returned to base, repair time in excess of 30 days occurred.

So, I question whether or not the K-kill criteria is realistic when a large numerical threat exists, and large caliber systems have limited rates of fire and present greater logistical burdens. Thus, to realistically determine the characteristics of a system, we must go far beyond the single statement of a kill criteria.

In the case of air-to-air missiles, again the desire for a K-kill is leading to greater sophistication in warhead design, fuzing and guidance in an environment of reduced weight for missiles.

I urge the OR/SA community not to accept blindly the criteria developed in the past, but concentrate on analyzing the real world situation and apply or develop appropriate criteria. The threat, technology and operational requirements of today are entirely different from those of WW II and must be reflected in the criteria we use for evaluation. Although I've only discussed air targets the same arguments hold for ground targets.

5. ENVIRONMENTAL CONSIDERATIONS

Another critical factor to consider is the environment. Given a weapon or weapon systems for evaluation, the environment in which it is to perform is a basic, critical consideration. Today in the U.S. we have come to depend on sophisticated and accurate systems. The OR/SA community has done many studies in support of decisions on laser guided (COPPERHEAD), Smart Bombs, electro optical (MAVERICK) and wireguided (TOW) systems.

How realistic are these analyses? Until the 1973 Arab/Israeli War, I must say they were not very realistic. The extensive use of guided systems in 1973, prompted us to relearn the lessons on the use of smoke. In the U.S. considerable effort is being expanded to quantify the effects of smoke, dust, and poor weather. I hope we have not gone too far on precision systems!

Going back to the Vietnam War, again reminds me of how the OR/SA community lacked realism in its treatment of the environment. We traditionally evaluated weapons in open terrain, however, in Vietnam we had marsh grass and rain forests.

The OR/SA community had generated data recommending usage of weapons and fuzes based on the open terrain. Needless to say, the data base did not apply and as a result we launched a very aggressive data collection program.

Today we have a much better data base for realistic assessment of weapons. But as weapon designs change and become more sophisticated, these data base must be updated. Otherwise, OR/SA in the weapons area could mislead the decision maker.

Before leaving this area, I raise a word of caution. In accepting data on new systems or analyses on systems, we must take into account the impact of the particular environment considered and the appropriate operational application.

6. LOGISTICS SUPPORT

Now, after a system is fielded - how about its logistical support? The most effective system is useless in the field if it cannot be supported. The logistical support system is very complex and costly. OR/SA can definitely make a significant contribution in this area, however, to date very limited application of OR/SA has been seen.

In the U.S. considerable emphasis is being placed on spare parts provisioning - for both nominal wearout and combat damage. Again, a review of Vietnam combat data has led us to relearn the lesson that the spare parts required for combat are much different than those required in peacetime operations.

This is illustrated very clearly by examining damage to armored vehicles. When an armored vehicle is damaged by a threat weapon, the wiring harness suffers damage. We do not stock wiring harness because they do not wearout in peacetime. Another example is the fuel cell in helicopters. The fuel cell represents a large presented area on the helicopter and is frequently damaged in combat. In the U.S. we stock very few fuel cells - again because they do not wearout.

We have not performed too well in the logistical area. A significant study effort is required to address realistically the required logistical support for key systems. In addition, reliable data collection efforts are required. To improve the data base, special sample data collection programs are established. Also, AMSAA has a unique mission of sending teams to the field to investigate the performance of equipment and as a result identifies problem areas for future investigation. These investigations range from redesign to maintenance of equipment as well as identifying requirements for changes in TO&E*, training and support. There is a great deal of money, time and resources devoted to new developments, new technology - but not that much money and resources dedicated toward improving fielded equipment. Why not? That is what my field liaison program accomplishes - IMPROVING FIELDED EQUIPMENT. This program thrives on realism. We do not rely on reports, or on surveys - we rely on "face-toface" contact with the soldier in the field. The program offers an excellent check on equipment performance in the hands of the soldier versus proving ground assessments of performance.

7. SUMMARY

I have attempted to provide you my thoughts on areas where I think OR/SA needs increased emphasis. In summary, we must concentrate on a well balanced and realistic approach supported by reasonable data from many sources. Too much emphasis on one element, too much emphasis on computer techniques, too much emphasis on complex simulations can all lead to misleading results.

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*Table of Organization and Equipment

I think the OR/SA military approach will have greater realism if we remember analysis is a cyclical procedure involving predictive models, supported by data and tests. A key to success is to take advantage of field operations including combat data collection.

Let us remember OR is not Operations Research - It is Operational Research.

I wish you success in your search of methods and data to solve today's problems.

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